FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/2268
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/089434

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/DE00/03417	28 September 2000 (28.09.00)	30 September 1999 (30.09.99)

TITLE OF INVENTION
DATA TRANSMISSION METHOD AND DEVICE

APPLICANT(S) FOR DO/EO/US
KOWALEWSKI, Frank

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unsigned).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☒ A substitute specification and marked-up version thereof.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report (translated), International Preliminary Search Report (translated) and Form PCT/RO/101.

EXPRESS MAIL NO.: EV003625972US

JC10 Rec'd PCT/PTO 29 MAR 2002

U.S. APPLICATION NO. if known, see 37 C.F.R.1.5	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/089434	PCT/DE 00/03417	10191/2268

17. ☐ The following fees are submitted:

	CALCULATIONS | PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EUROPEAN PATENT OFFICE or JPO $890.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00	
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

Claims	Number Filed	Number Extra	Rate	
Total Claims	6 - 20 =	0	X $18.00	$ 0
Independent Claims	2 - 3 =	0	X $84.00	$ 0
Multiple dependent claim(s) (if applicable)			+ $280.00	$
TOTAL OF ABOVE CALCULATIONS =				$ 890
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$
SUBTOTAL =				$ 890
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$
TOTAL NATIONAL FEE =				$ 890
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$ 0
TOTAL FEES ENCLOSED =				$ 890
			Amount to be: refunded	$
			charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$890.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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New York, New York 10004

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SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

3/29/02
DATE

[10191/2268]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Frank KOWALEWSKI
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	DATA TRANSMISSION AND DEVICE
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of the claims, first line, change "What is claimed is:" to:
--What Is Claimed Is:--.

Please cancel claims 1-6 in the underlying PCT application, without prejudice. Please also cancel, without prejudice, claims 1-6 in the Annex of the International Preliminary Eamination Report.

Please add the following new claims:

--7. (New) A data transmission method, comprising:

transmitting a CDMA-coded data signal between a transmitter and a receiver in the form of a data stream of spread data bursts using hierarchical CDMA codes;

detecting data corresponding to a mother code of at least one of the codes;

despreading the detected data using at least one generator;

aborting the detecting if the data has been despread to a sufficient extent; and

repeating the despreading step using the data last despread if the data has not been despread to the sufficient extent to obtain receiving data.

8. (New) The method according to claim 7, wherein the detecting step includes detecting the data using a rake receiver, and wherein the despreading step includes despreading the detected data using a despreading device connected downstream from the rake receiver.

9. (New) The method according to claim 8, further comprising:

performing a preliminary despreading operation in the rake receiver.

10. (New) The method according to claim 7, wherein the detecting step includes detecting the data using a joint detection receiver configured to eliminate mutual interference of transmitted data, and wherein the despreading step includes despreading the detected data using a despreading device connected downstream from the joint detection receiver.

11. (New) The method according to claim 10, further comprising:

performing a preliminary despreading operation in the joint detection receiver.

12. (New) A device for receiving a CDMA-coded data signal transmitted in the form of a data stream of spread data bursts using hierarchical CDMA codes, comprising:

a first stage configured to detect spread data according to a mother code of at least one of the codes; and

a second stage downstream from the first stage configured to despread the detected data using the one or more generators, the second downstream stage being configured to abort detection if the data has been despread to a sufficient extent and to repeat the despreading using

the data last despread until the data has been despread to the sufficient extent to obtain receiving data.--.

Remarks

This Preliminary Amendment cancels claims 1-6 in the underlying PCT application, without prejudice. This Preliminary Amendment also cancels, without prejudice, claims 1-6 in the Annex to the International Preliminary Examination Report ("IPER"). The Preliminary Amendment also adds new claims 7-12. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT application, PCT/DE00/03417 includes an International Search Report, dated March 1, 2001. A translation of the Search Report is annexed hereto.

The underlying PCT application also includes an IPER dated January 17, 2002. A translation of the IPER and the annex thereto is annexed hereto.

Applicant submits that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,
KENYON & KENYON

Dated: 3/29/02

By: _____
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1/prts

DATA TRANSMISSION METHOD AND DEVICE

Background Information

The present invention relates to a data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver in the form of a data stream of spread data bursts, with hierarchical CDMA codes being used for transmission; the present invention also concerns a data transmission device.

Although, in principle, applyable to any data transmission system, the present invention and its underlying object are explained on the basis of a cellular CDMA (Code Division Multiple Access) data transmission system.

CDMA-coded data transmitted via multipath channels may be detected by rake reception or methods which eliminate mutual data interference.

In particular, Code Division Multiple Access (CDMA) enables multiple data streams to be transmitted simultaneously via a common frequency band. Using spreading codes, the data stream symbols to be transmitted are converted into signal fragments of the same length as the spreading codes. The signal fragments of the data symbols corresponding to a point in time are summed up and the summed fragments transmitted according to their time sequence, as is known from K. D. Kammeyer, Message Transmission, 2nd Edition, Information Technology Series, Teubner, Stuttgart, 1996.

It is possible to convert the received signal fragments back to the data symbols of the data streams by despreading them

with the spreading codes. If the signals are transmitted via multiple paths (as in the case of mobile telephony), it is advantageous to despread the signals separately for all paths and, after weighting the despread signals on all paths (using the coefficients of the channel pulse response), sum them up again. A CDMA receiver which operates in this manner is called a rake receiver.

Multipath transmission causes mutual interference of the transmitted signals at the receiver. In contrast to the rake receiver, this interference may be eliminated in the receiver, for example by joint detection (JD), as is known from A. Klein, G. K. Kaleh and P. W. Baier: "Zero Forcing and Minimum Mean-Square-Error Equalization for Multiuser Detection in Code-Division Multiple-Access Channels", IEEE Trans. Vehic. Tech., Vol. 45 (1996), 276-287.

CDMA codes having a large spreading factor may be constructed from two codes having a smaller spreading factor, using Kronecker multiplication. A set of CDMA codes constructed in this manner is known as a hierarchical code set. The OVSF (Orthogonal Variable Spreading Factor) codes used in UMTS (Universal Mobile Telephone System) are hierarchically constructed codes (see Concept Group Alpha: "EVALUATION DOCUMENT (DRAFT 1.0), Part 1", ETSI Tdoc SMG2 270/97).

The rake receiver and the joint detection method for receiving hierarchical codes are unnecessarily complex and unnecessarily expensive.

Advantages of the Invention

The idea underlying the present invention is that the received CDMA signals are first detected using a smaller-than-necessary spreading factor and are then despread using the codes employed to construct the hierarchical codes.

The data transmission method according to the present invention having the features described in Claim 1 and the data transmission device according to Claim 6 have the particular advantage that they allow the detection of data spread using hierarchical codes less expensively than when employing a rake receiver or carrying out joint detection of the user data.

The subordinate claims describe advantageous embodiments and refinements of the method according to the present invention in Claim 1.

According to a preferred embodiment, the data is detected by a rake receiver in a first step, and despreading is carried out in a despreading device connected downstream from the rake receiver.

According to another preferred embodiment, a preliminary despreading operation is carried out in the rake receiver (RE).

According to a further preferred embodiment, the data is detected by a JD receiver in the first step, using a detection method which eliminates mutual interference of the transmitted data, and despreading takes place in a despreading device connected downstream from the JD receiver.

According to a further preferred embodiment, a preliminary despreading operation is carried out in the JD receiver.

Drawings

An exemplary embodiment of the present invention is illustrated in the drawing and explained in greater detail in the following description, where

Figure 1 shows a representation of a hierarchical code tree which illustrates one embodiment of the present invention; and

Figure 2 shows a block diagram of a device for detecting hierarchically coded CDMA signals according to one embodiment of the present invention.

Description of the Exemplary Embodiments

Figure 1 shows the construction of hierarchical codes. In Figure 1, reference symbol SF represents the spreading factor and $c^{(i,j)}$ the corresponding spreading codes.

Codes $c^{(i+1,k)}$ having a larger spreading factor are formed by Kronecker multiplication from a given code$^{(i,j)}$ which has a smaller spreading factor, using generators a, b.

The structure of hierarchical codes makes it possible to iteratively despread hierarchically spread data in the receiver, using a corresponding inverse Kronecker multiplication operation.

In the present example, CDMA data is transmitted with hierarchical codes via a multipath channel, using OVSF codes according to Figure 1 and a rake reception method in the receiver.

However, the rake reception method is quite different from the related art, since complete despreading does not take place within the rake receiver, but rather in downstream despreaders. In the specific example, despreading is not carried out at all in the rake receiver.

Figure 2 shows a corresponding device. In Figure 2. reference symbol RE represents a rake receiver, E1 ... En are despreaders, and DS represents the despread data symbols.

The rake receiver first detects the data corresponding to mother code $c^{(1,1)}$, using the known rake reception method.

The master data detected in the previous step is then despread by despreading it with generators a and/or b, thereby calculating a mother code of the receiving code using a larger spreading factor: SF = 2 in this case.

The master data detected in the previous step is then despread again, using SF = 2, by despreading it with generators a and/or b, thereby calculating the receiving data using spreading factor SF = 4, which is then output for further processing as data stream DS.

If the data obtained in the second step has been despread to a sufficient extent, it is generally accepted as the detected data. If this is not the case, the second step is repeated using the data obtained in the previous second step until the receiving data is available.

For this purpose, the receiver also detects the spreading factor of the data output by rake receiver RE as well as generators a and b.

Although the present invention was described above on the basis of a preferred exemplary embodiment, it is not limited to this embodiment but can be modified in many different ways.

Although the first embodiment involves transmitting CDMA data having hierarchical codes via a multipath channel having OVSF codes according to Figure 1 and carrying out a rake reception method in the receiver, a joint-detection (JD) reception method may also take place in the receiver.

In particular, the method according to the present invention may be applied to all data transmission systems which use a

transmission mode in which data coded with hierarchical CDMA codes are to be detected.

Although the rake receiver does not perform a despreading operation in the specific embodiment, the rake receiver may perform a preliminary despreading operation, e.g., using SF = 2.

New Claims

What is claimed is

1. A data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver (RE, E1, ..., En) in the form of a data stream of spread data bursts, with hierarchical CDMA codes being used for transmission; with data corresponding to a mother code $c^{(i,j)}$ of the one or more receiving codes being detected in a first step; and with the detected data being despread using one or more generators (a, b) in a second step,
wherein the detection process is aborted in a third step if the data has been despread to a sufficient extent to obtain receiving data, or, if this is not the case, the second step is repeated using the data last despread until the data has been despread to a sufficient extent to obtain receiving data.

2. The method according to Claim 1,
wherein the data is detected by a rake receiver (RE) in the first step, and the despreading operation takes place in a despreading device (E1 ..., En) connected downstream from the rake receiver (RE).

3. The method according to Claim 2,
wherein a preliminary despreading operation is carried out in the rake receiver (RE).

4. The method according to Claim 1,
wherein the data is detected by a JD receiver in the first step, using a detection method which eliminates mutual interference of the transmitted data, and the despreading operation is carried out in a despreading device (E1 ..., En) connected downstream from the JD receiver.

5. The method according to Claim 4,
wherein a preliminary despreading operation is carried out in the JD receiver.

6. A device for carrying out the method according to at least one of the preceding claims,
characterized by a receiving device (RE, E1 …, En) comprising

a first stage (RE) for detecting spread data according to a mother code $c^{(i,j)}$ of the one or more receiving codes; and

a second downstream stage (E1 …, En) for despreading the detected data by despreading it using one or more generators (a, b); having means for aborting the detection process if the data has been despread to a sufficient extent to obtain receiving data, and for repeating the despreading operation using the data last spread until the data has been despread to a sufficient extent to obtain receiving data.

Abstract

Data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver (RE, E1 …, En) in the form of a data stream of spread data bursts, with hierarchical CDMA codes being used for transmission. Spread data is detected in a first step according to a mother code $c^{(i,j)}$ of the one or more receiving codes. The detected data is despread in a second step by despreading it using the one or more generators. The detection process is aborted in a third step if the data has been despread to a sufficient extent, or, if this is not the case, the second step is repeated using the data last despread until the data has been despread to a sufficient extent.

(Fig. 2)

[10191/2268]

DATA TRANSMISSION METHOD AND DEVICE

[Background Information] FIELD OF THE INVENTION

The present invention relates to a data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver in the form of a data stream of spread data bursts, with hierarchical CDMA codes [being] used for transmission[; the]. The present invention also concerns a data transmission device.

BACKGROUND INFORMATION

Although, in principle, [applyable] applicable to any data transmission system, the present invention [and its underlying object are] is explained on the basis of a cellular CDMA (Code Division Multiple Access) data transmission system.

CDMA-coded data transmitted via multipath channels may be detected by rake reception or methods which eliminate mutual data interference.

In particular, Code Division Multiple Access (CDMA) enables multiple data streams to be transmitted simultaneously via a common frequency band. Using spreading codes, the data stream symbols to be transmitted are converted into signal fragments of the same length as the spreading codes. The signal fragments of the data symbols corresponding to a point in time are summed up and the summed fragments are transmitted according to their time sequence, as is [known from] described in K. D. Kammeyer, Message Transmission, 2nd Edition, Information Technology Series, Teubner, Stuttgart, 1996.

[It is possible to convert the] The received signal fragments may be converted back to the data symbols of the data streams by despreading them with the spreading codes. If the signals are transmitted via multiple paths (as in the case of mobile telephony), it [is] may be advantageous to despread the signals separately for all paths and, after weighting the despread signals on all paths (using the coefficients of the channel pulse response), sum them up again. A CDMA receiver which operates in this manner [is] may be called a rake receiver.

Multipath transmission [causes] may cause mutual interference of the transmitted signals at the receiver. In contrast to the rake receiver, this interference may be eliminated in the receiver, for example by joint detection (JD), as [is known from] described in A. Klein, G. K. Kaleh and P. W. Baier: "Zero Forcing and Minimum Mean-Square-Error Equalization for Multiuser Detection in Code-Division Multiple-Access Channels", IEEE Trans. Vehic. Tech., Vol. 45 (1996), 276-287.

CDMA codes having a large spreading factor may be constructed from two codes having a smaller spreading factor, using Kronecker multiplication. A set of CDMA codes constructed in this manner [is known] may be referred as a hierarchical code set. The OVSF (Orthogonal Variable Spreading Factor) codes used in UMTS (Universal Mobile Telephone System) are hierarchically constructed codes (see Concept Group Alpha: "EVALUATION DOCUMENT (DRAFT 1.0), Part 1", ETSI Tdoc SMG2 270/97).

The rake receiver and the joint detection method for receiving hierarchical codes [are] may be unnecessarily complex and unnecessarily expensive.

SUMMARY OF THE INVENTION

In accordance with an example embodiment [Advantages] of [the Invention

The idea underlying] the present invention [is that], the received CDMA signals [are] may be first detected using a smaller-than-necessary spreading factor and [are] may then be despread using the codes employed to construct the hierarchical codes.

[The] A data transmission method according to an example embodiment of the present invention [having the features described in Claim 1 and the data transmission device according to Claim 6 have the particular advantage that they] may allow the detection of data spread using hierarchical codes to be less [expensively] expensive than when employing a rake receiver or [carrying out] performing joint detection of the user data.

[

The subordinate claims describe advantageous embodiments and refinements of the method according to the present invention in Claim 1.

According to a preferred] According to one example embodiment, the data [is] may be detected by a rake receiver in a first step, and despreading [is carried out] may be performed in a despreading device connected downstream from the rake receiver.

According to another [preferred] example embodiment, a preliminary despreading operation [is carried out] may be performed in the rake receiver (RE).

According to a further [preferred] example embodiment, the data [is] may be detected by a JD receiver in the first step, using a detection method which eliminates mutual interference

of the transmitted data, and despreading [takes place] may occur in a despreading device connected downstream from the JD receiver.

According to a further [preferred] example embodiment, a preliminary despreading operation [is carried out] may be performed in the JD receiver.

[Drawings] BRIEF DESCRIPTION OF THE DRAWINGS

[An exemplary] Figure 1 shows a representation of a hierarchical code tree which illustrates one example embodiment of the present invention [is illustrated in the drawing and explained in greater detail in the following description, where].

[Figure 1 shows a representation of a hierarchical code tree which illustrates one]Figure 2 shows a block diagram of a device for detecting hierarchically coded CDMA signals according to one example embodiment of the present invention[; and].

[Figure 2 shows a block diagram of a device for detecting hierarchically coded CDMA signals according to one embodiment of the present invention.] DETAILED DESCRIPTION

[Description of the Exemplary Embodiments

Figure 1 shows the] Figure 1 shows a construction of hierarchical codes. In Figure 1, reference symbol SF represents the spreading factor and $c^{(i,j)}$ represents the corresponding spreading codes.

Codes $c^{(i+1,k)}$ having a larger spreading factor are formed by Kronecker multiplication from a given code$^{(i,j)}$ which has a smaller spreading factor, using generators a, b.

The structure of hierarchical codes [makes] may make it possible to iteratively despread hierarchically spread data in the receiver, using a corresponding inverse Kronecker multiplication operation.

In the present example embodiment, CDMA data [is] may be transmitted with hierarchical codes via a multipath channel, using OVSF codes according to Figure 1 and a rake reception method in the receiver.

However, the rake reception method is [quite] different from the related art, since complete despreading does not [take place] occur within the rake receiver, but rather in downstream despreaders. In the [specific] example embodiment, despreading is not [carried out at all] performed in the rake receiver.

Figure 2 shows a corresponding device. In Figure 2[.] reference symbol RE represents a rake receiver, E1 ... En are despreaders, and DS represents the despread data symbols.

The rake receiver first detects the data corresponding to mother code $c^{(1,1)}$, using the [known] conventional rake reception method.

The master data detected in the previous step [is] may then be despread by despreading it with generators a and/or b, thereby calculating a mother code of the receiving code using a larger spreading factor: SF = 2 in this case.

The master data detected in the previous step [is] may then be despread again, using SF = 2, by despreading it with generators a and/or b, thereby calculating the receiving data using spreading factor SF = 4, which [is] may then be output for further processing as data stream DS.

If the data obtained in the second step has been despread to a sufficient extent, it [is generally] may be considered accepted as the detected data. If this is not the case, the second step [is] may be repeated using the data obtained in the previous second step until the receiving data is available.

For this purpose, the receiver may also [detects] detect the spreading factor of the data output by rake receiver RE as well as generators a and b.

Although the present invention [was] is described above on the basis of [a preferred exemplary] an example embodiment, it is not limited to this embodiment but [can] may be modified in many different ways.

Although the first example embodiment involves transmitting CDMA data having hierarchical codes via a multipath channel having OVSF codes according to Figure 1 and [carrying out] performing a rake reception method in the receiver, a joint-detection (JD) reception method may also [take place] occur in the receiver.

In particular, the example method according to the present invention may be applied to all data transmission systems which use a transmission mode in which data coded with hierarchical CDMA codes are to be detected.

Although the rake receiver [does] may not perform a despreading operation in the [specific] example embodiment, the rake receiver may perform a preliminary despreading operation, e.g., using SF = 2.

[Abstract] ABSTRACT

[Data] A data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver [(RE, E1 …, En)] in the form of a data stream of spread data bursts, with hierarchical CDMA codes [being] used for transmission. Spread data is detected in a first step according to a mother code [c(i,j) of the] of at least one [or more] receiving [codes] code. The detected data is despread in a second step by despreading it using [the] at least one [or more generators] generator. The detection process is aborted in a third step if the data has been despread to a sufficient extent, or, if this is not the case, the second step is repeated using the data last despread until the data has been despread to a sufficient extent.

[(Fig. 2)]

[10191/2268]

DATA TRANSMISSION METHOD AND DEVICE

FIELD OF THE INVENTION

The present invention relates to a data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver in the form of a data stream of spread data bursts, with hierarchical CDMA codes used for transmission. The present invention also concerns a data transmission device.

BACKGROUND INFORMATION

Although, in principle, applicable to any data transmission system, the present invention is explained on the basis of a cellular CDMA (Code Division Multiple Access) data transmission system.

CDMA-coded data transmitted via multipath channels may be detected by rake reception or methods which eliminate mutual data interference.

In particular, Code Division Multiple Access (CDMA) enables multiple data streams to be transmitted simultaneously via a common frequency band. Using spreading codes, the data stream symbols to be transmitted are converted into signal fragments of the same length as the spreading codes. The signal fragments of the data symbols corresponding to a point in time are summed up and the summed fragments are transmitted according to their time sequence, as is described in K. D. Kammeyer, Message Transmission, 2nd Edition, Information Technology Series, Teubner, Stuttgart, 1996.

The received signal fragments may be converted back to the data symbols of the data streams by despreading them with the spreading codes. If the signals are transmitted via multiple paths (as in the case of mobile telephony), it may be advantageous to despread the signals separately for all paths and, after weighting the despread signals on all paths (using the coefficients of the channel pulse response), sum them up again. A CDMA receiver which operates in this manner may be called a rake receiver.

Multipath transmission may cause mutual interference of the transmitted signals at the receiver. In contrast to the rake receiver, this interference may be eliminated in the receiver, for example by joint detection (JD), as described in A. Klein, G. K. Kaleh and P. W. Baier: "Zero Forcing and Minimum Mean-Square-Error Equalization for Multiuser Detection in Code-Division Multiple-Access Channels", IEEE Trans. Vehic. Tech., Vol. 45 (1996), 276-287.

CDMA codes having a large spreading factor may be constructed from two codes having a smaller spreading factor, using Kronecker multiplication. A set of CDMA codes constructed in this manner may be referred as a hierarchical code set. The OVSF (Orthogonal Variable Spreading Factor) codes used in UMTS (Universal Mobile Telephone System) are hierarchically constructed codes (see Concept Group Alpha: "EVALUATION DOCUMENT (DRAFT 1.0), Part 1", ETSI Tdoc SMG2 270/97).

The rake receiver and the joint detection method for receiving hierarchical codes may be unnecessarily complex and unnecessarily expensive.

SUMMARY OF THE INVENTION

In accordance with an example embodiment of the present invention, the received CDMA signals may be first detected using a smaller-than-necessary spreading factor and may then

be despread using the codes employed to construct the hierarchical codes.

A data transmission method according to an example embodiment of the present invention may allow the detection of data spread using hierarchical codes to be less expensive than when employing a rake receiver or performing joint detection of the user data.

According to one example embodiment, the data may be detected by a rake receiver in a first step, and despreading may be performed in a despreading device connected downstream from the rake receiver.

According to another example embodiment, a preliminary despreading operation may be performed in the rake receiver (RE).

According to a further example embodiment, the data may be detected by a JD receiver in the first step, using a detection method which eliminates mutual interference of the transmitted data, and despreading may occur in a despreading device connected downstream from the JD receiver.

According to a further example embodiment, a preliminary despreading operation may be performed in the JD receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a representation of a hierarchical code tree which illustrates one example embodiment of the present invention.

Figure 2 shows a block diagram of a device for detecting hierarchically coded CDMA signals according to one example embodiment of the present invention.

DETAILED DESCRIPTION

Figure 1 shows a construction of hierarchical codes. In Figure 1, reference symbol SF represents the spreading factor and $c^{(i,j)}$ represents the corresponding spreading codes.

Codes $c^{(i+1,k)}$ having a larger spreading factor are formed by Kronecker multiplication from a given $code^{(i,j)}$ which has a smaller spreading factor, using generators a, b.

The structure of hierarchical codes may make it possible to iteratively despread hierarchically spread data in the receiver, using a corresponding inverse Kronecker multiplication operation.

In the present example embodiment, CDMA data may be transmitted with hierarchical codes via a multipath channel, using OVSF codes according to Figure 1 and a rake reception method in the receiver.

However, the rake reception method is different from the related art, since complete despreading does not occur within the rake receiver, but rather in downstream despreaders. In the example embodiment, despreading is not performed in the rake receiver.

Figure 2 shows a corresponding device. In Figure 2 reference symbol RE represents a rake receiver, E1 … En are despreaders, and DS represents the despread data symbols.

The rake receiver first detects the data corresponding to mother code $c^{(1,1)}$, using the conventional rake reception method.

The master data detected in the previous step may then be despread by despreading it with generators a and/or b, thereby calculating a mother code of the receiving code using a larger spreading factor: SF = 2 in this case.

The master data detected in the previous step may then be despread again, using SF = 2, by despreading it with generators a and/or b, thereby calculating the receiving data using spreading factor SF = 4, which may then be output for further processing as data stream DS.

If the data obtained in the second step has been despread to a sufficient extent, it may be considered accepted as the detected data. If this is not the case, the second step may be repeated using the data obtained in the previous second step until the receiving data is available.

For this purpose, the receiver may also detect the spreading factor of the data output by rake receiver RE as well as generators a and b.

Although the present invention is described above on the basis of an example embodiment, it is not limited to this embodiment but may be modified in many different ways.

Although the first example embodiment involves transmitting CDMA data having hierarchical codes via a multipath channel having OVSF codes according to Figure 1 and performing a rake reception method in the receiver, a joint-detection (JD) reception method may also occur in the receiver.

In particular, the example method according to the present invention may be applied to all data transmission systems which use a transmission mode in which data coded with hierarchical CDMA codes are to be detected.

Although the rake receiver may not perform a despreading operation in the example embodiment, the rake receiver may perform a preliminary despreading operation, e.g., using SF = 2.

ABSTRACT

A data transmission method in which a CDMA-coded data signal is transmitted between a transmitter and a receiver in the form of a data stream of spread data bursts, with hierarchical CDMA codes used for transmission. Spread data is detected in a first step according to a mother code of at least one receiving code. The detected data is despread in a second step by despreading it using at least one generator. The detection process is aborted in a third step if the data has been despread to a sufficient extent, or, if this is not the case, the second step is repeated using the data last despread until the data has been despread to a sufficient extent.

FIG 1

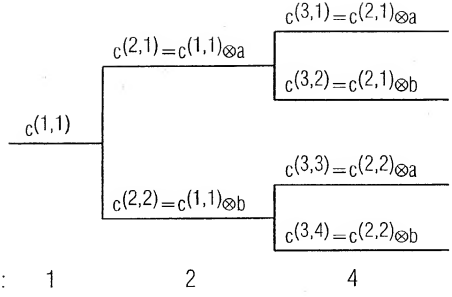
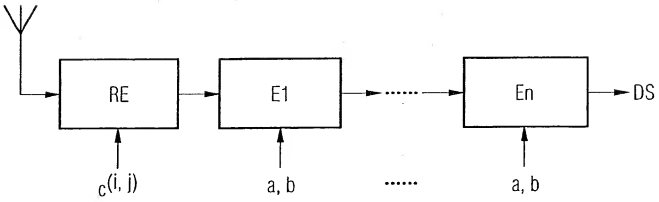


FIG 2



[10191/2268]

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **DATA TRANSMISSION METHOD AND DEVICE**, the specification of which was filed as International Application No. PCT/DE00/03417 on September 28, 2000.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country filed	Day/month/year	Priority Claimed Under 35 USC 119
199 46 872.9	Federal Republic of Germany	30 September 1999	Yes

And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and Gerard A. Messina (Reg. No. 35,952) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please address all communications regarding this application to:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor(s): **Frank KOWALEWSKI**

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